Slough). San Joaquin River flows were again high, precluding the installation of the HOR barrier.

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DSM2 1997 DYE SIMULATION

Tara Smith, DWR

INTRODUCTION

As mentioned in the previous article, on 28 April 1997, the US Geological Survey (USGS) released 48 L of dye from the Mossdale railroad bridge over the San Joaquin River. Eight water quality samplers, located at eight different sites in the south Delta, were used to track the movement of dye. This dye release was simulated using the Delta Simulation Model 2 (DSM2) and the results, comparing computed to observed, are presented in this article.

DESCRIPTION

The simulation was conducted using the quality portion of DSM2 1997 hydrodynamics validation, which can be found at wwwdelmod/docs/dsm2/calval/valid.html. During the time frame of the study, the Old River at Head barrier was in place. It contained two culverts with a capacity of passing approximately 300 ft^3/s. Forty-eight liters of tracer, over a 15-minute period, were released into the San Joaquin River at the DSM2 grid location corresponding to the Mossdale site. The dye concentration observed at eight locations was compared to model results at the same sites (Figure 1).

RESULTS AND DISCUSSION

Figures 2 through 4 show a few of the concentration plots. From these graphs, travel time, dispersion, and concentrations were analyzed for each observation site. Following are some general comments comparing the model's results to observed data shown in Figure 1.

There was a strong match between the travel time of the simulated tracer and the observed data. The timing of the peaks between observed and computed were within a couple of hours. (This is excluding the Old River at CC Ferry site which did not have accurate observed data.)

This study was particularly helpful in showing how well DSM2 models dispersion in various areas of the Delta. The quality portion of DSM2 is calibrated using salinity. Since there are several continuous sources of salinity, it is impossible to determine the local dispersion effects. Examining the plots show that in some areas of the Delta, such as the Stockton site, the model had greater dispersion. At other sites, like Turner Cut or at San Joaquin at Mandeville (not shown), model dispersion was less.

Difference in concentrations between the model and observed data, are a result of differences in channel velocities, flow splits, or dispersion. Additionally, the USGS considers concentrations below 0.04 g/L as background concentrations.

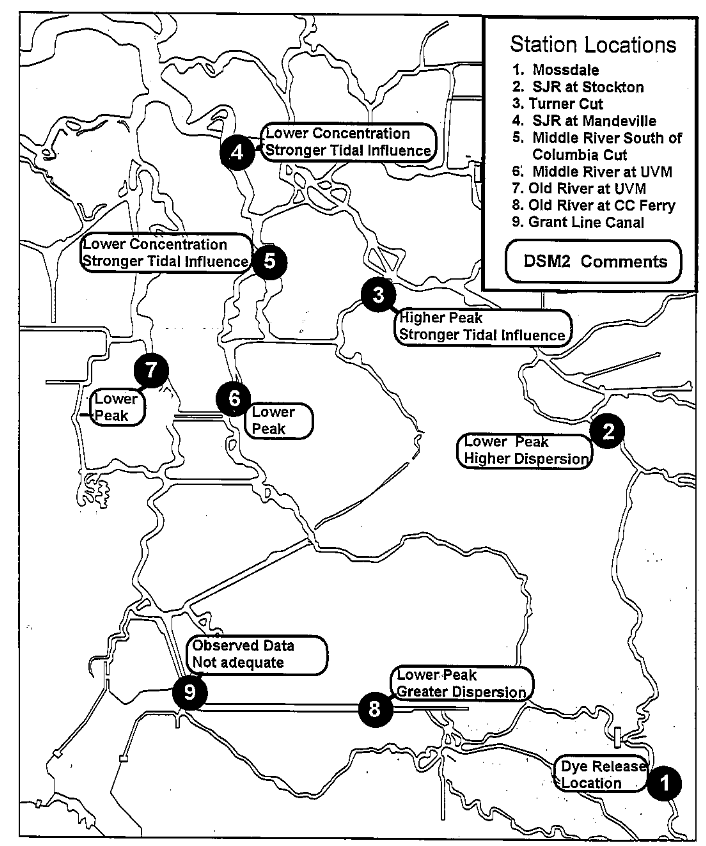

Figure 1 Sacramento-San Joaquin Delta dye measurement sites from April through May 1997

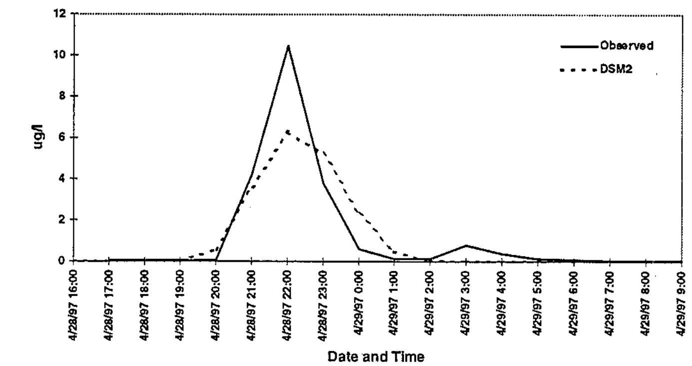

Figure 2 Observed vs. DSM2 dye concentration at the San Joaquin River at Stockton

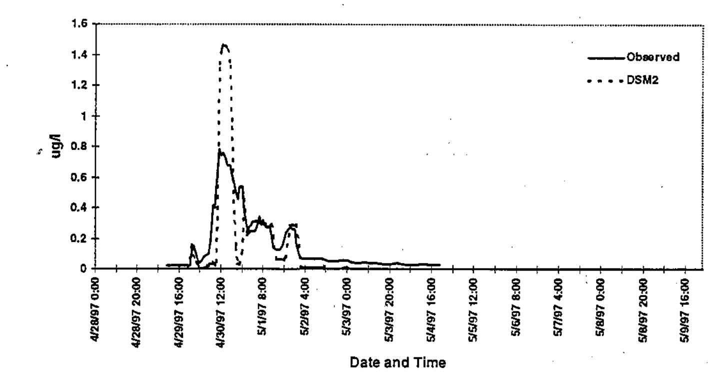

Figure 3 Observed vs. DSM2 dye concentration at Turner Cut

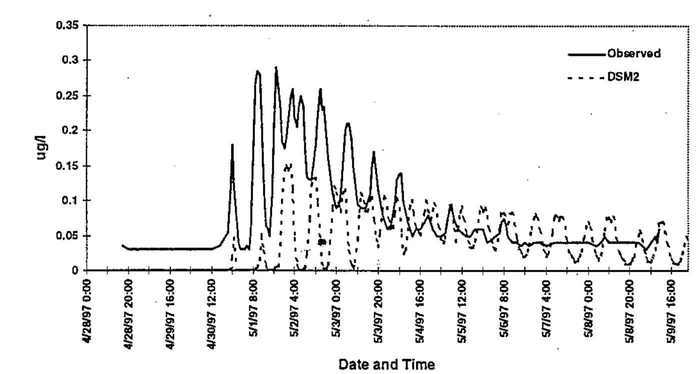

Figure 4 Observed vs. DSM2 dye concentration at Grant Line Canal

DSM2 1997 Dye Simulation

CONCLUSIONS

In general, the DSM2 did well in simulating the travel time of the dye. Areas for greatest improvement are in the modeling of dispersion. DSM2 is currently being recalibrated by the DSM2 Project Work Team with newly collected bathemetry data. Hopefully this calibration with its improved model geometry will provide a better match between model results and observed data.

NON-INDIGENOUS JELLYFISH IN THE UPPER SAN FRANCISCO ESTUARY: POTENTIAL IMPACTS ON ZOOPLANKTON AND FISH

John Rees, CSU Hayward

INTRODUCTION

There were almost certainly no native coelenterates in the native planktonic (as well as benthic) fauna of the upper San Francisco Estuary (northern San Pablo Bay and its tributaries and Suisun Bay). Today this area of generally low and variable salinity is host to a number of introduced cnidarians, especially hydroids (Cohen and Carlton 1995). Whereas hydroids have been reported from the upper estuary for many years (Hand 1951), hydroid jellyfish (hydromedusae) were not reported here until 1993, when two species, *Maeotias inexpectata* and *Blackfordia virginica* were collected in the Petaluma River (Mills and Sommer 1995). Since that time, a third hydromedusan introduction into the estuary has been collected, an as yet undesignated species of *Moerisia* (Rees and Gershwin, forthcoming). Preliminary field sampling and discussions with agency personnel and fisherman in the field indicate that all three species are present in the upper estuary. These jellyfish are thought to be present in the plankton from at least May through November, with peak abundances occurring from August though October. Anecdotal evidence suggests an increasing frequency of occurrence coupled with higher population densities within the upper estuary over the past ten years.

There are several reasons why jellyfish introductions into the ecologically sensitive upper estuary are not welcome. While not all alien introductions result in observable negative results to the receiving ecosystem, some do. The mitten crab (*Eriochier sinensis*) is among the most notorious recent local examples. Since they occupy the same ecological niche as fish in the aquatic food web as secondary consumers, jellyfish can be ecological competitors with resident fish species. Jellyfish are also known predators on fish eggs, fry, and juveniles, and can compete directly for zooplankton with juvenile and adult fish (Purcell 1985).

More worrisome are worldwide anecdotal reports of recent increasing jellyfish populations correlated with declines in resident fish populations. While evidence is scant and data difficult to interpret, there have been several recent reports of scyphozoan jellyfish populations increasing in areas where important commercial fisheries are located, such as the Bering Sea (Mills 1995; Mills, personal communication). In the North American Grand Banks, normally benthic hydrozoan polyps as well as hydromedusae have been recorded in high abundances in the plankton, and have been observed feeding directly on larval cod (S. Bollens, personal communication). Jellyfish are apparently filling a niche in some aquatic food webs formerly filled by fish. Whether hydrozoan populations will decrease in response to increasing fish populations is not known.

PRELIMINARY FIELD METHODS

Random plankton sampling was conducted at selected sites in North San Pablo and Suisun bays during 1997 and 1998. Sampling was done by a variety of methods, including routine plankton tows (with a 0.25 m diameter, 0.5 mm mesh net), hand nettings from boats and docks, and agency mid-channel tows. In one sampling excursion on the Napa River on 7 September 1998, mid-water and bottom plankton tows were taken in mid-channel at three locations along a ten-mile transect: (1) in the broad channel below the train trestle, (2) off Cuttings Wharf, and (3) north of the Kennedy Boat Launch just below the city of Napa. Other sampling was routinely conducted from August through November when jellyfish seem to be most abundant. It is known, however, that medusae had to be present in the water column before August and perhaps as early as May, since adults of all three species (the juveniles having been released several months previously) were routinely collected by August. Quantification of this initial sampling was not attempted. Salinity and temperature measurements were taken with a refractometer and conductivity meter, and growth stages of medusae were noted.

RESULTS

Figure 1 shows various views of adult medusae of the three introduced species. For identification purposes, note that these are only the adult stages, and that growth stages as well as adults of any one or all three species may be present simultaneously in the water column.

Maeotias inexspectata is the largest, most conspicuous, and most readily identifiable of the three species. Bell diameters reach 4 cm or more, and the reddish coloration of the bell, coupled with white or brownish gonads, render this jellyfish easily visible at the surface, even when the water is quite turbid. The other two species, *Blackfordia virginica* and *Moerisia* sp. are smaller (0.5 to 1.5 cm in bell height and width) and, except for the gonads, are transparent, rendering these two species virtually invisible in the field, particularly in turbid water. All three have persistent benthic polypoid stages, but polyps and colonies have been found in the field so far for only two: *B. virginica* and *Moerisia* species. *Maeotias inexspectata* polyps and colonies are certainly present, perhaps in abundance.

Salinity and temperature spectra for medusae collected in the estuary have ranged from 2.5‰ to 11‰ and 16.5 to 25 °C, respectively. Calder (1967, 1969) reported *Moerisia lyonsi* in the Chesapeake Bay in salinities of 2.3‰, and *M. inexspectata* in salinities as low as 1.2‰. It is anticipated that estuary species have similar salinity tolerance profiles. Basic ecological data (including salinity and temperature tolerances and ranges for polyps, growth stages of medusae, diets, feeding behaviors, life histories, population dynamics, and times of initial annual appearance in the plankton), are not known for any of the three species. Mills and Sommer (1995) report that in the Petaluma River *M. inexspectata* adults fed primarily on zooplankton, but at least one adult *M. inexspectata* collected by the author in the Napa River in 1998 had a small, unidentified fish in its gut; *B. virginica* adults have been collected with their stomachs packed with zooplankton. In a Napa River collection in September 1998, *B. virginica* medusae were found in great numbers on the bottom; further upriver, they were present in abundance (about 5 individuals per m^3) in the water column on an incoming tide. Similarly, adult *M. inexspectata* medusae were routinely observed along a one-mile length of the Napa River near the shore in shallow water, but adults were not collected by routine tows in mid-channel. *Maeotias inexspectata* was also observed in virtually all quiet water areas of the Napa River (marinas, boat launches, shorelines) from the city of Napa to at least Cuttings Wharf, a distance of about 5 miles, in early September 1998. Sampling procedures for jellyfish and other invertebrates in shallow water habitats are not well developed, and methods for sampling in these areas need to be devised and implemented to obtain reliable estimates of abundance.

While most observations of medusae to date have been made in the more accessible rivers and sloughs of the upper estuary, there is no reason to assume that jellyfish are confined to shallow water habitats. Preliminary IEP results in 1998 revealed the presence of adult *M. inexspectata* in mid-channel from Mare Island to the "mothball" fleet and the Concord Naval Weapons station (and points in between) from 15 September to 15 October in salinities and temperatures ranging from 2.6‰ to 10.4‰ and 16.5 to 21.8 °C, respectively (R. Gartz, personal communication). More thorough tow collections will likely reveal the presence of jellyfish in deeper mid-channel estuary habitats, particularly during late summer and early fall.

Medusae have exhibited a sporadic and bewildering pattern of appearance in the estuary. *Maeotias inexspectata* and *B. virginica* were collected in the Petaluma River in downtown Petaluma during summer 1995 in great numbers, but were absent from this location in 1997 and 1998. *Maeotias inexspectata* and *Moerisia* sp. were routinely collected adjacent to the Suisun City marina in high abundances (about 10 to 20 per m^3) in 1997, but both were absent in 1998. Appropriate salinity ranges, temperatures, and hydrological conditions probably play a pivotal, but as yet unknown, role in the development of abundant medusa populations, and wet and dry years may prove to exhibit very different patters of medusa occurrence and abundance. Laboratory and field work will help delineate optimum salinities and temperatures for favorable development of field populations of medusae.

It is not known when these hydrozoans were introduced into the estuary. Discussions with agency personnel and other field workers have alluded to the presence of *M. inexspectata* in Suisun Slough as early as 1979 (P. Moyle, personal communication) and near Chipps Island in high densities during the mid-1990s (J. McLain and K. Webb, personal communications). One fisherman questioned along the Napa River in 1998 stated that he first noted jellyfish in about 1985 (undoubtedly the more readily observable *M. inexspectata*), and has subsequently noted increasing numbers over the intervening years. Several boaters testified that jellyfish had been present in the